MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

TCS3511 THEORY OF COMPUTING/ TIC2151 THEORY OF COMPUTATION/

(All sections / Groups)

09 March 2016
9:00 am – 11:00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages only excluding the cover page.
2. Attempt all questions. All questions carry equal marks and the distribution of the marks for each question is given.
2. Please write your answers in the answer booklet provided. Please write the question number of each answer clearly.

QUESTION (1)

NOTE: Attempt any THREE out of FOUR Parts (A), (B), (C) and (D).

(A)

1. Prove the following by construction:
   For any integers a and b, if a and b are odd, then ab is odd. [2.5 marks]

2. Prove the following by contradiction:
   Given that r is a rational number and x is an irrational number. Show that: $r + x$ is irrational. [2.5 marks]

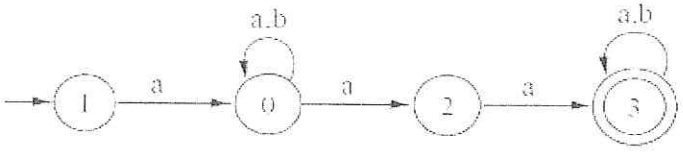
(B) Draw state diagrams for DFAs accepting the following languages:

$L_1 = \{w \in \{a, b\}^* | w$ is the set of strings that start and end with the same letter $\}$ [2.5 marks]

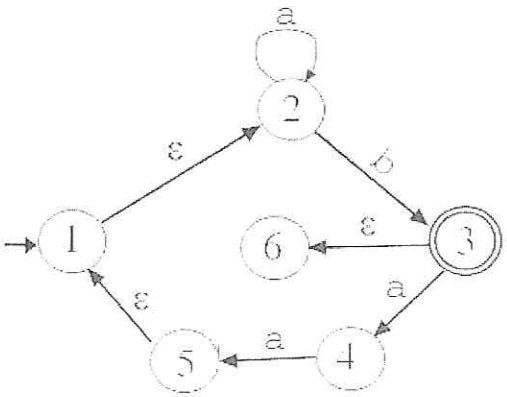
$L_2 = \{w \in \{a, b\}^* | w = a^2 b^m, m \geq 0\}$ [2.5 marks]

(C)

1. Draw the state diagram of the DFA that accepts the same language as the following NFA. [2 marks]



2. Convert the following NFA into an NFA without ε-transitions. Show the transition table and the corresponding state diagram. [3 marks]



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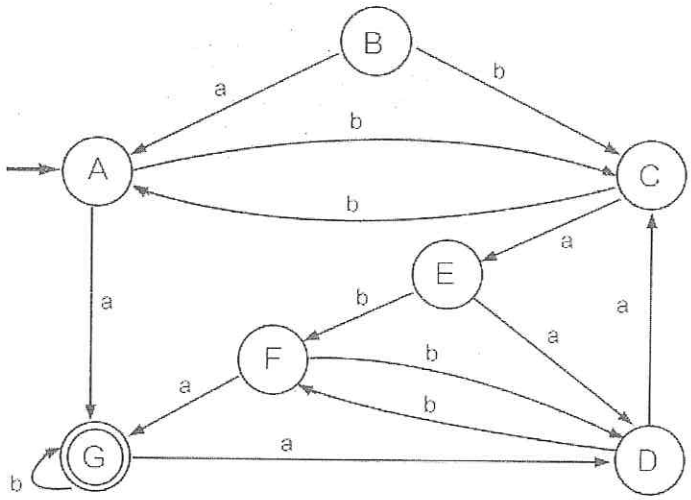
(D) Minimize the following DFA. Show your steps. [5 marks]



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QUESTION (2)

(A)

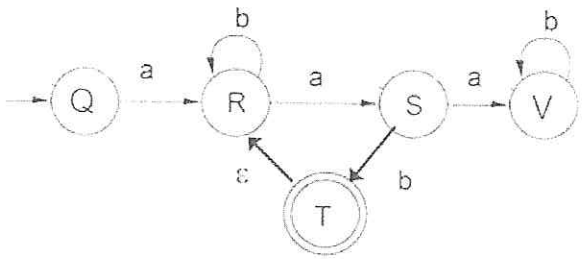
1. Determine the language corresponding to each of the following regular expressions. [2 marks]
   i. a(a* ∪ b)
   ii. 1* + 1*01* + 1*01*01*
2. Find a regular expression corresponding to each of the following languages. [3 marks]
   i. L = { w ∈ {0, 1}*| the length of w is 4}
   ii. L = { w | w contains 011 as a substring}
   iii. L = { w | String w is begins or ends with 00 or 11}

(B) Convert the following regular expression into an NFA. Follow the construction rules closely and do not just give a simpler NFA even though it is possible. [5 marks]

b(ab + a)*

(C)

1. What is the regular grammar corresponding to the NFA given below? [2 marks]



2. Give the regular grammars corresponding to each of the following languages over the alphabet {a, b}.

   L_1 = { w | w starts with *a* and ends with *bb* } [1.5 marks]

   L_2 = bb (ab)* [1.5 marks]

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QUESTION (3)

NOTE: Attempt any THREE out of FOUR Parts(A), (B), (C) and (D).

(A) Construct a PDA for each of the following languages:

$L_1 = \{a^n b^{2n} \mid n > 0\}$ [2.5 marks]

$L_2 = \{a^{n+m} b^m c^n \mid n,m \geq 1\}$ [2.5 marks]

(B) Give context-free grammars for each of the following languages:

$L_1 = w \in \{0, 1\}^* \mid$ w starts and ends with the same digit. [2.5 marks]

$L_2 = \{0^n 1^n \mid n \geq 0\} \cup \{1^n 0^n \mid n \geq 0\}$ [2.5 marks]

(C) Convert the following context-free grammar into Chomsky Normal Form (CNF). Show your main steps. [5 marks]

S => AbA
A => Aa | ε

(D) The following CFG grammar is in Chomsky normal form, use the Cocke-Younger-Kasami (CYK) algorithm to determine whether the words *ababbbaa* and *aabbabbb* can be derived from this grammar or not. Show your proof. [5 marks]

B => BB | XA | XY
A => BY
X => a
Y => b

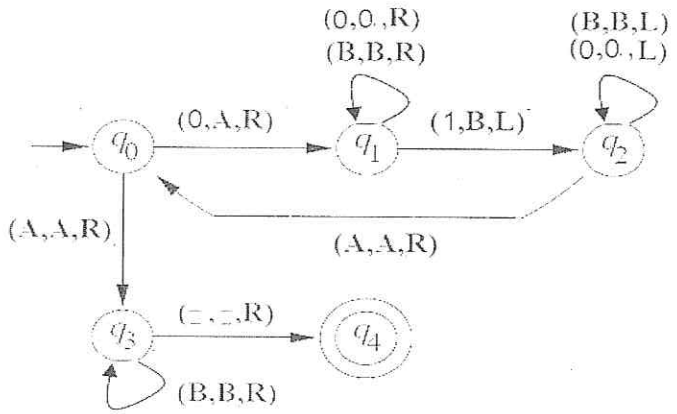
Continue...

QUESTION (4)

(A)

1. What language does the following Turing Machine accept? [1.5 marks]

2. Give the formal definition of this Turing Machine including the transition table. [3.5 marks]



(B) Construct a Turing Machine to work as a validator to insure that the input string on a tape has an even number of *a*'s and an even number of *b*'s. They can be arranged in any way, as long as the count of *a*'s and the count of *b*'s are both even. [5 marks]

(C)

1. Let $T = \{(i, j, k) \mid i, j, k \in \mathbb{N}\}$, $\mathbb{N}$ denotes the set of natural numbers. Show that T is countable. [2 marks]

2. Given the following two languages:
   $A_{DFA} = \{\langle B, w\rangle \mid B \text{ is a DFA that accepts input string } w\}$.
   $A_{NFA} = \{\langle C, w\rangle \mid C \text{ is a NFA that accepts input string } w\}$.

   A_{DFA} has been proven to be a decidable language. Prove that A_{NFA} is a decidable language as well. [3 marks]

End of page.